

**TEST TOOLS IN SUPPORT OF THE
ADVANCED THREAT INFRARED COUNTERMEASURES/
COMMON MISSILE WARNING SYSTEM
(ATIRCM/CMWS) ACQUISITION**



Mr. Jim Hatfield

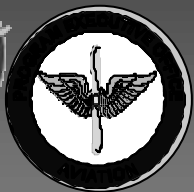


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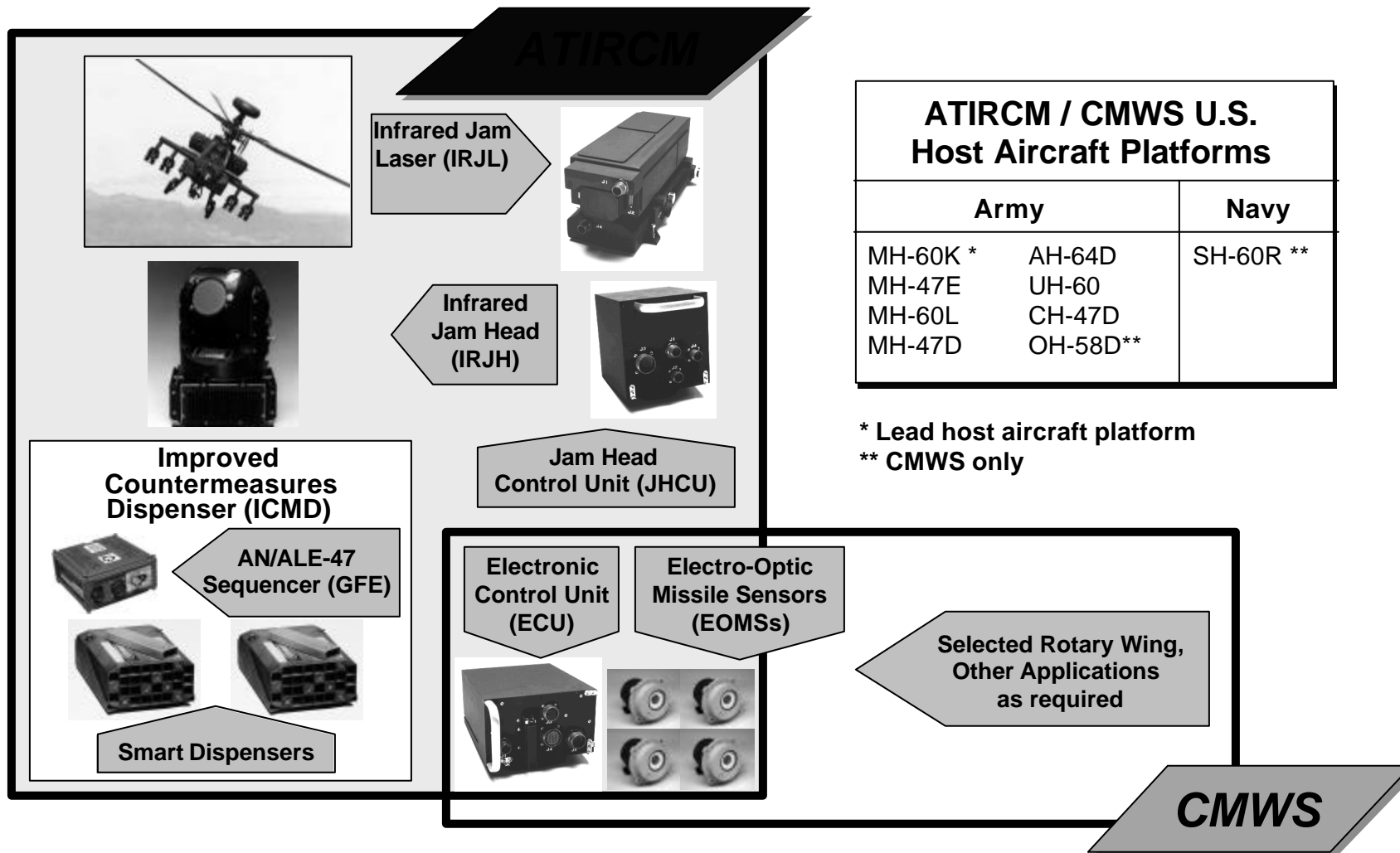


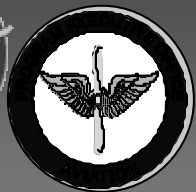
ATIRCM/CMWS

A system designed to provide aircraft defensive countermeasures, subject to crew override, for defeating incoming heat-seeking missile threats to USA attack, utility, cargo, and special operations aircraft.

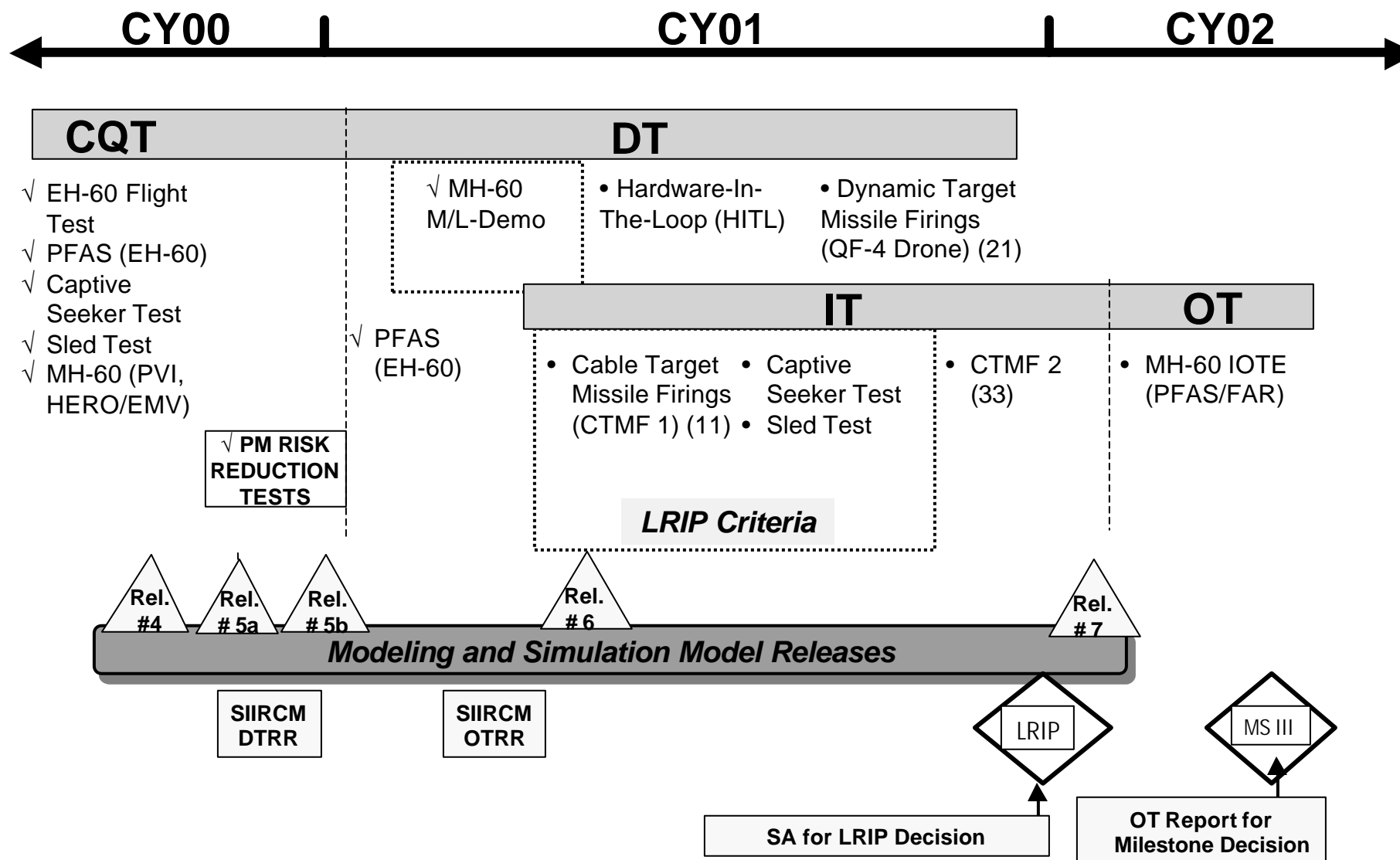


ATIRCM/CMWS OVERVIEW





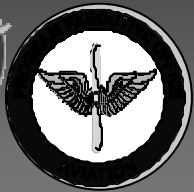
SYSTEM ASSESSMENT TIMELINE



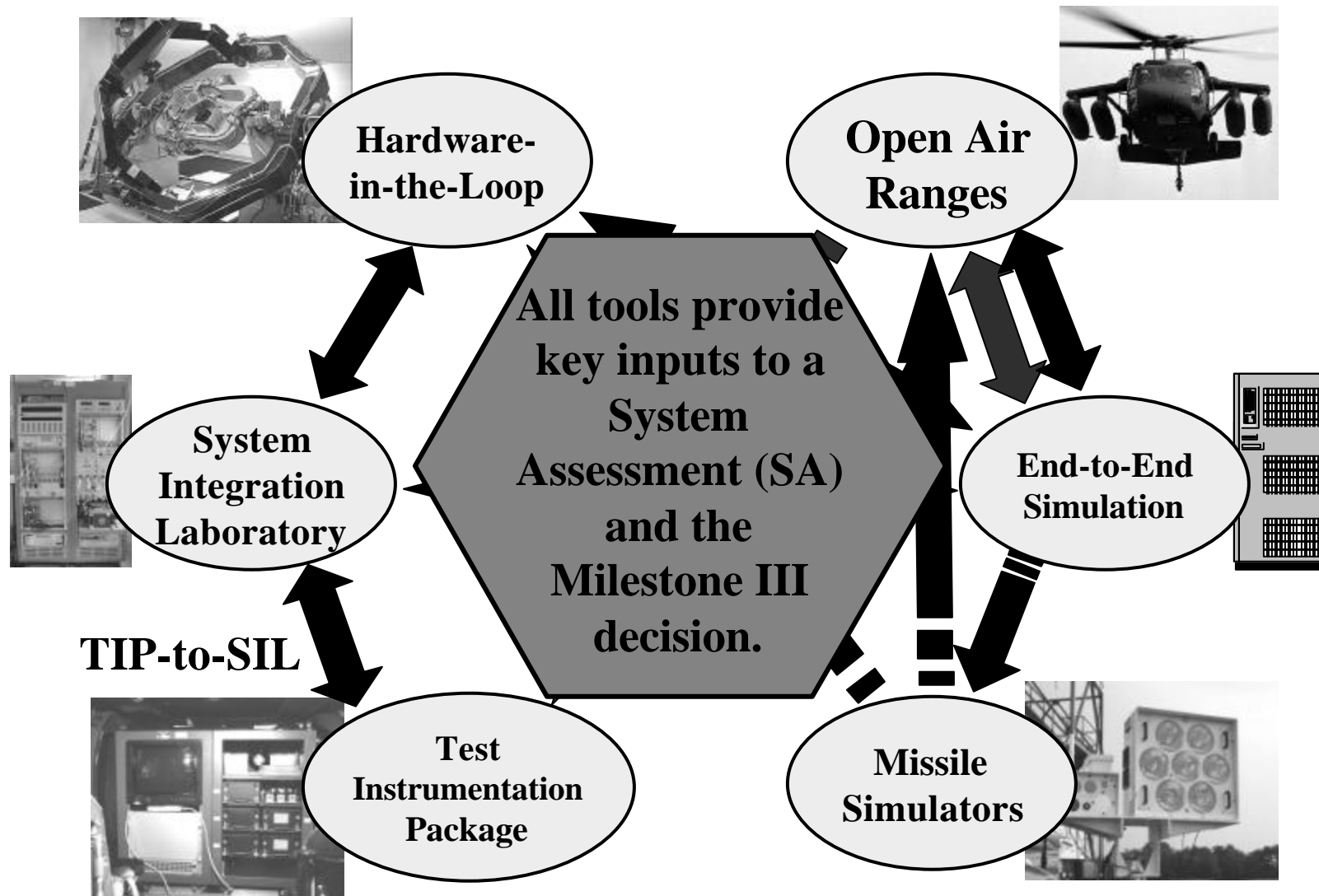


PROGRAM OBJECTIVES

- Calculate an estimated system False Alarm Rate (FAR)
- Determine the system Probability of Detection (P_D)
- Determine the system Probability of Countermeasure (P_{CM})
- Provide data to support a System Assessment (SA) for system effectiveness, suitability, and survivability



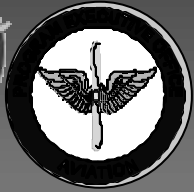
TOOLS



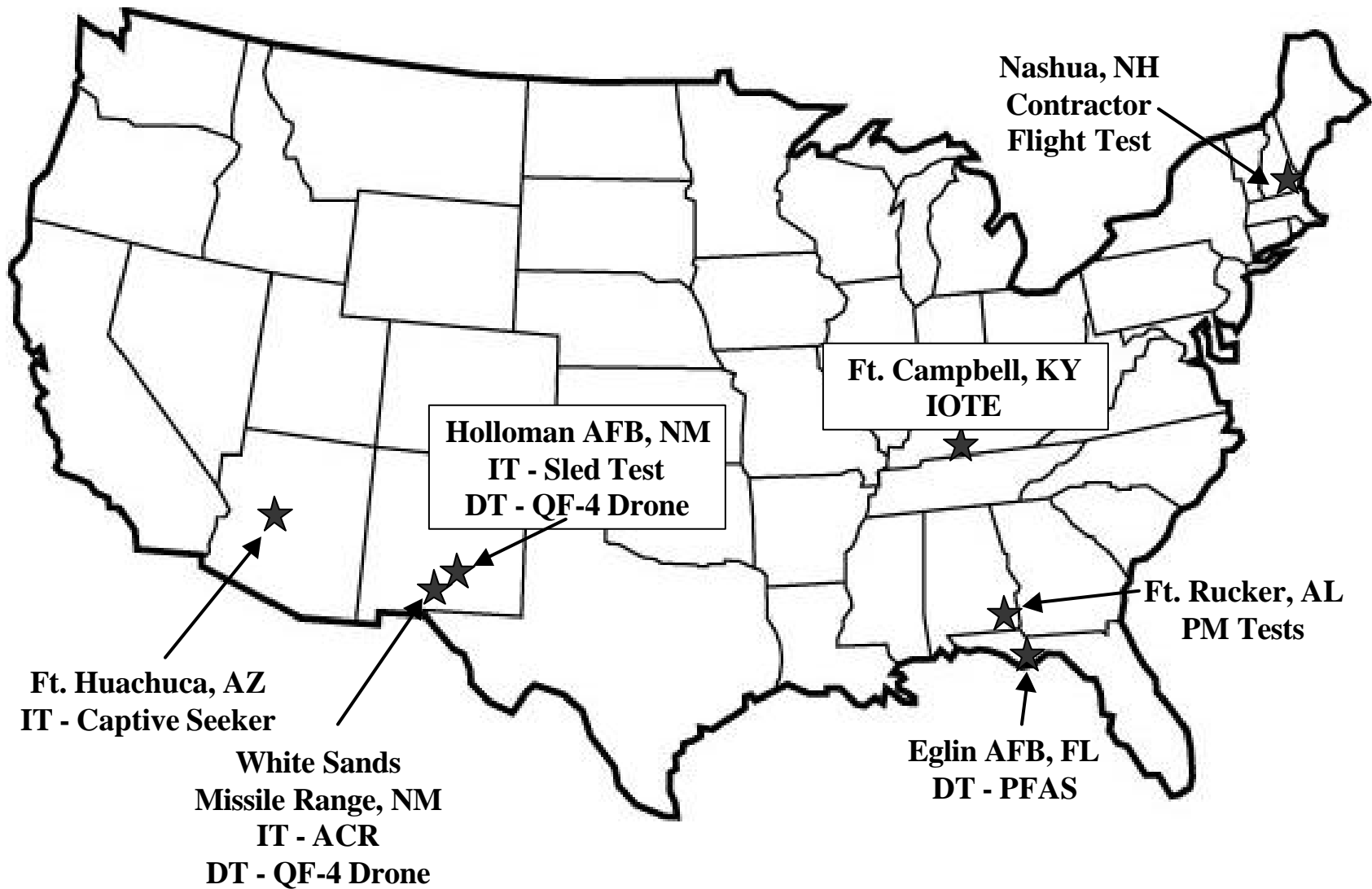


OPEN AIR RANGE (OAR) OBJECTIVES

- Measure system performance against Critical Technical Parameters by determining what Potential False Alarm Sources (PFAS), if any, produce false alarms.
- Collect PFAS signature data for input to the E2E Model and development of system algorithms.
- Provide data for a System Assessment on:
 - × The ability of the system to detect, declare and effectively counter an unrestrained missile launched at it, using selected Threat missiles. [65 missiles in three test events - Aerial Cable Range (2), QF-4 Drone missile firings]
 - × The system's ability to defeat threat missiles, and to determine system response during multiple-aircraft scenarios. [Captive Seeker Test]
 - × The ability of the system to detect, track, and direct energy onto a path-constrained, surrogate missile. [Sled Test]
- Verify compliance with selected system specifications and provide data for development and validation of the E2E Model.
- Evaluate the operational effectiveness and suitability of the system on the the lead system platform.

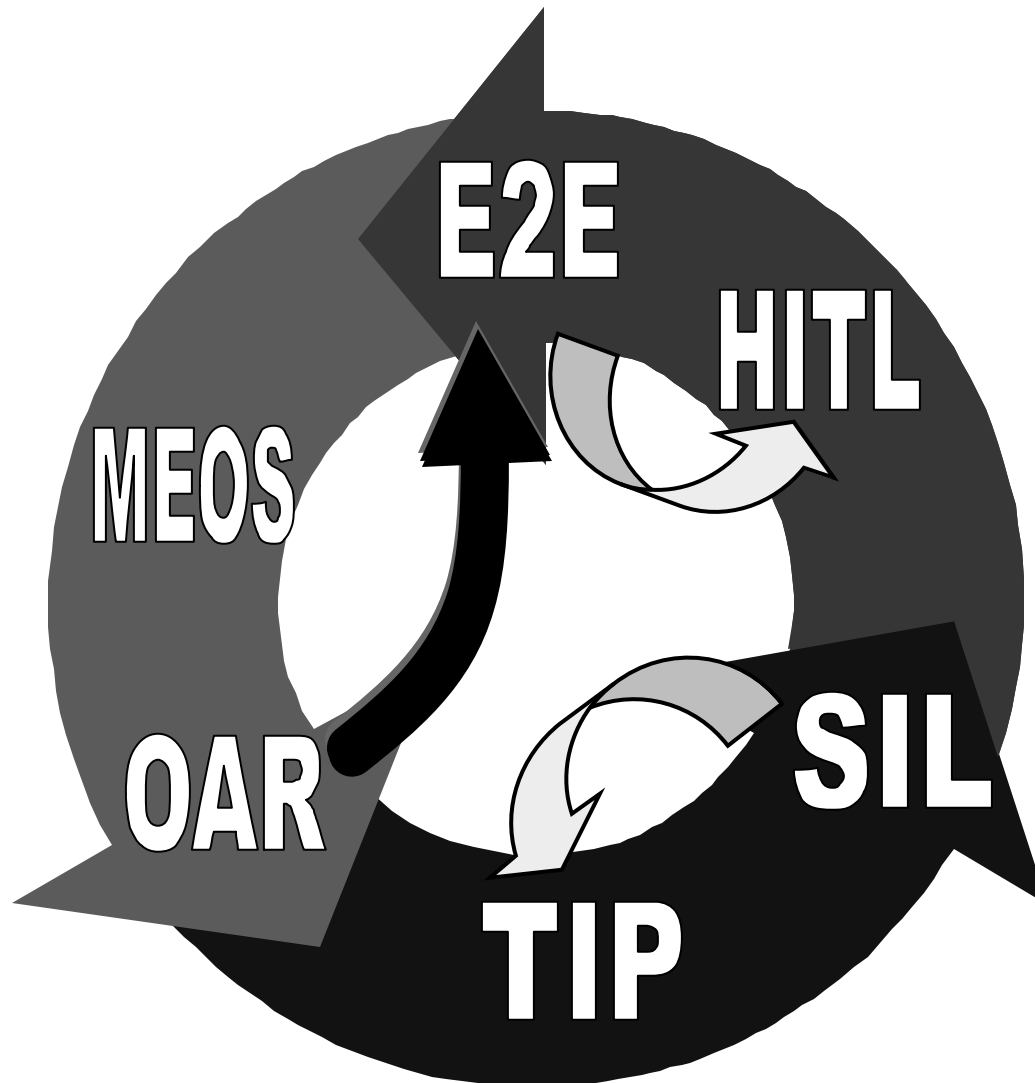


OPEN AIR RANGES (OAR)





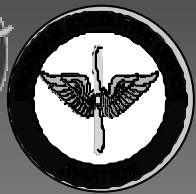
E2E SIMULATION



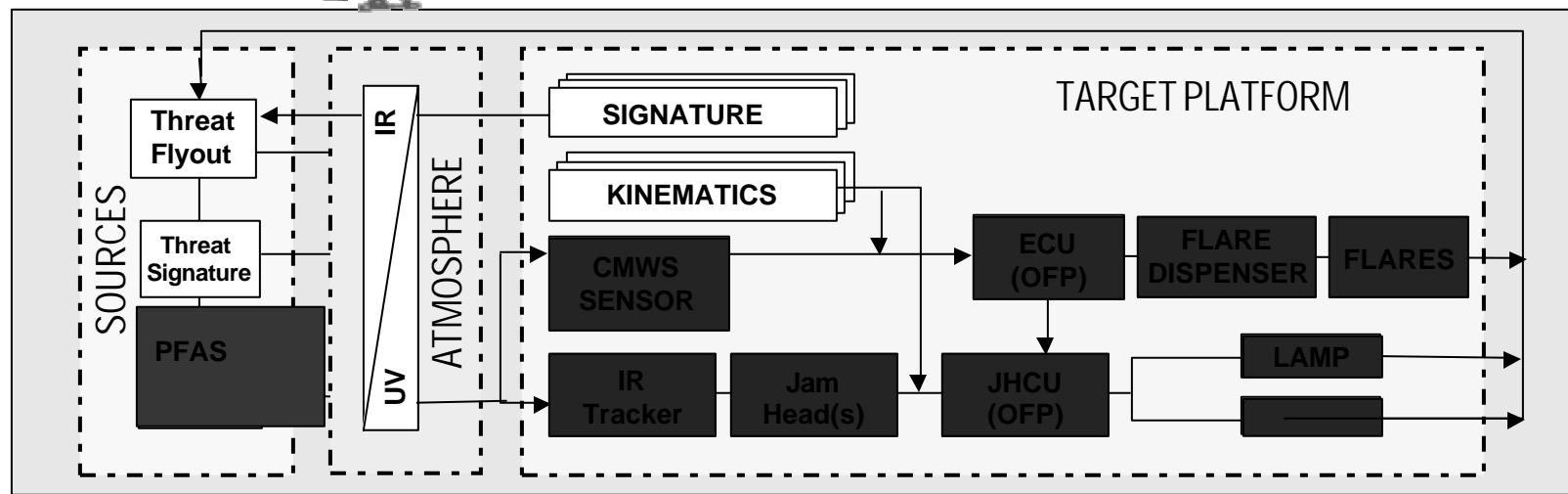
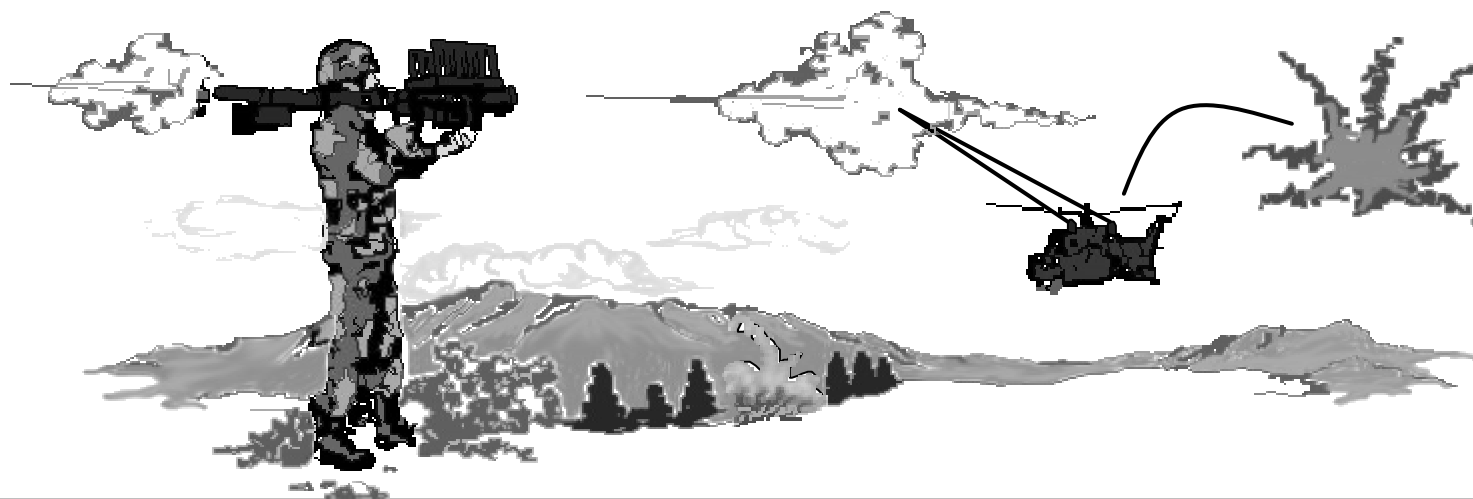


END-TO-END (E2E) OBJECTIVES

- Evaluate system performance against Critical Technical Parameters in support of pre-test planning and post-test evaluation.
- Supplement cases where ground or flight testing may be inadequate, impractical, or impossible.
- Support test planning and reduce risk through pre-test prediction of system performance.
- Aid in post-test resolution of anomalies.
- Provide M&S data as required in support of Hardware-in-the-Loop, Missile Simulator, and System Integration Laboratory test activities.



E2E MODEL ARCHITECTURE SUPPLEMENTS LIVE FIRE TESTING



• 2.5 Million Lines of Code



TEST TOOLS & INSTRUMENTATION

- TSPI
 - × Aircraft INS
 - × Missile TM kits, laser TM
- Atmospherics
 - × Ozone particle counter
 - × MET instrumentation
- Platform & System Performance Recording
 - × Test Instrumentation Package (TIP)
- Signature measurement (Missiles, PFAS)
 - × UV and IR radiometers
 - × UV Spectrometer
- Missile Simulator
 - × Super Multi-role Electro Optical Stimulator (SMEOS)
- Live Run Replay
 - × System Integration Lab (SIL)
- Video

Above instrumentation can be applied to other programs as appropriate



SUPER MULTI-ROLE ELECTRO-OPTICAL STIMULATOR (SMEOS)

- Portable, ground-based test set for Ultraviolet and Infrared warning and defense systems
- Simulates the UV/IR signature of the launch and approach of a missile
 - × Independently Programmable UV and IR channels
 - × Main Unit and Beacon Boost Module (BBM) can operate independently
- Data Acquisition Unit (DAU)
 - × Control of system functions
 - × Collect and store data signals
 - × Remote operation capability





SUPER MEOS

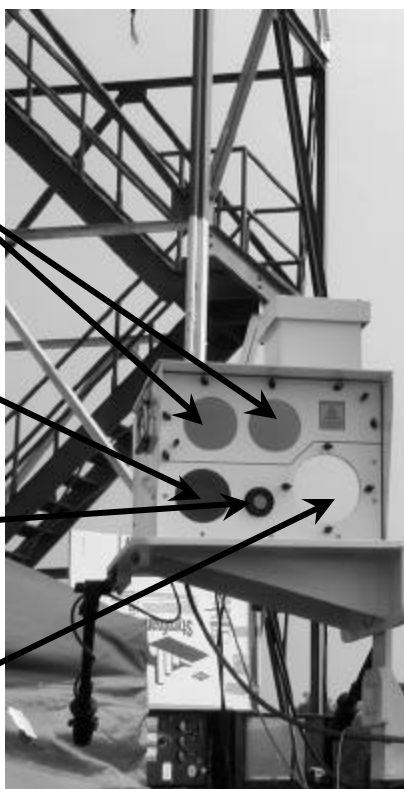
MAIN UNIT

IR Sources

Camera

Radiometer

UV
Aperture



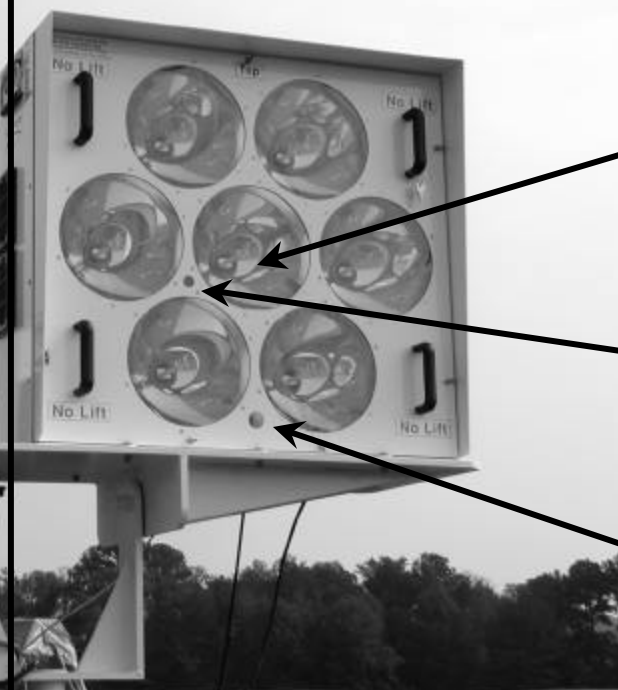
- Max. In-band Radiant Intensity - 362mW/sr
- FWHM ~ 7 deg.
- Max. 32 sec. Duration profile
- Shutter allows fast rise/fall times
- IR Radiometer - User selectable MGC/AGC
- Witness sensor monitoring UV channel

BEACON BOOST MODULE (BBM)

IR Lamps

Radiometer

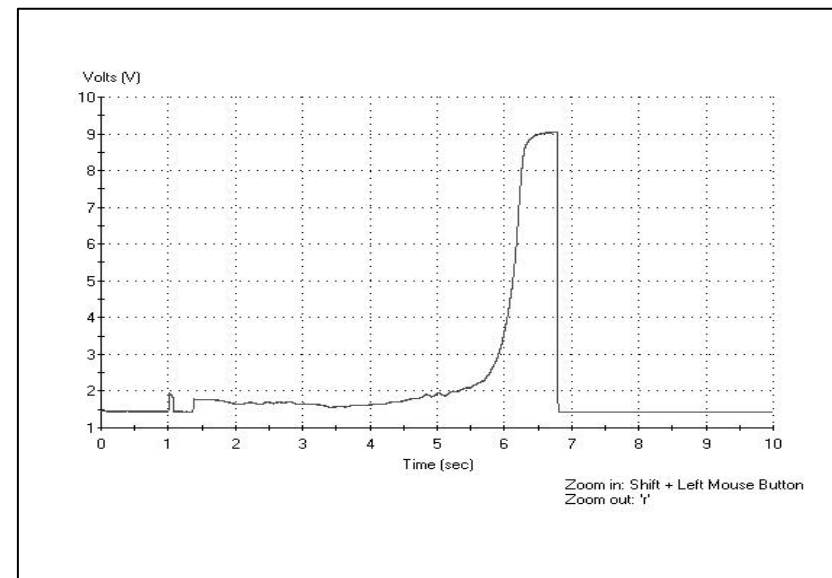
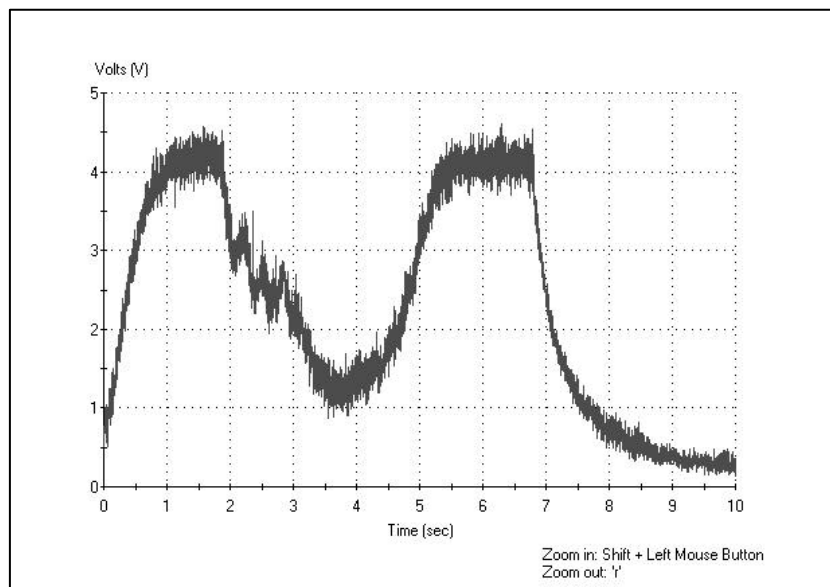
Gun
Sight



- Provides 150 watts/steradian in-band
- FWHM ~3 deg.
- Optical Witness sensor monitors center lamp
- Synthesized witness sensor for multiple lamp engagement



SUPER MEOS



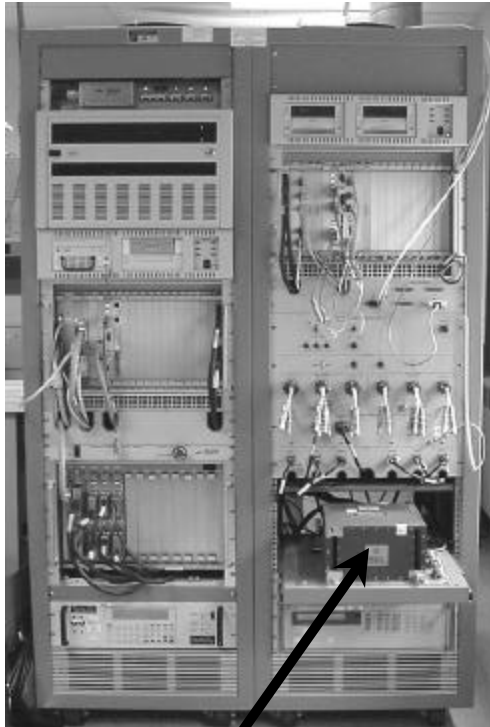


SYSTEM INTEGRATION LABORATORY (SIL) - OBJECTIVES

- Evaluate system performance against Critical Technical Parameters in a simulated operational environment.
- Evaluate system performance against selected Threat missiles and PFASs, using a TRADOC-approved Threat laydown.
- Reconcile the results of SIL simulations with all-digital simulations where appropriate.



SYSTEMS INTEGRATION LAB (SIL)



**ELECTRONIC
CONTROL UNIT
(ECU)**

■ Capabilities

Enables real-time functioning of system algorithms hosted in the actual Electronic Control Unit (ECU) hardware with Operational Flight Program (OFP).

- ↓ Primary inputs are sensor output, host aircraft INS data, and ECU gyroscope outputs recorded during flight test.
- ↓ SIL recorded output is real-time Ethernet and 1553 message traffic; used for assessment of system declaration performance.

■ Applications

- × Performance predictions for flight test planning.
- × Performance assessment to extend test conditions beyond those realizable in flight test.
- × Regression testing of ECU modifications (hardware and software) using TIP data from flight test.
- × Correlation Tool with E2E and HITL



TEST INSTRUMENTATION PACKAGE (TIP)

Power Control

**Monitor, Aydin
R9010 R/20**

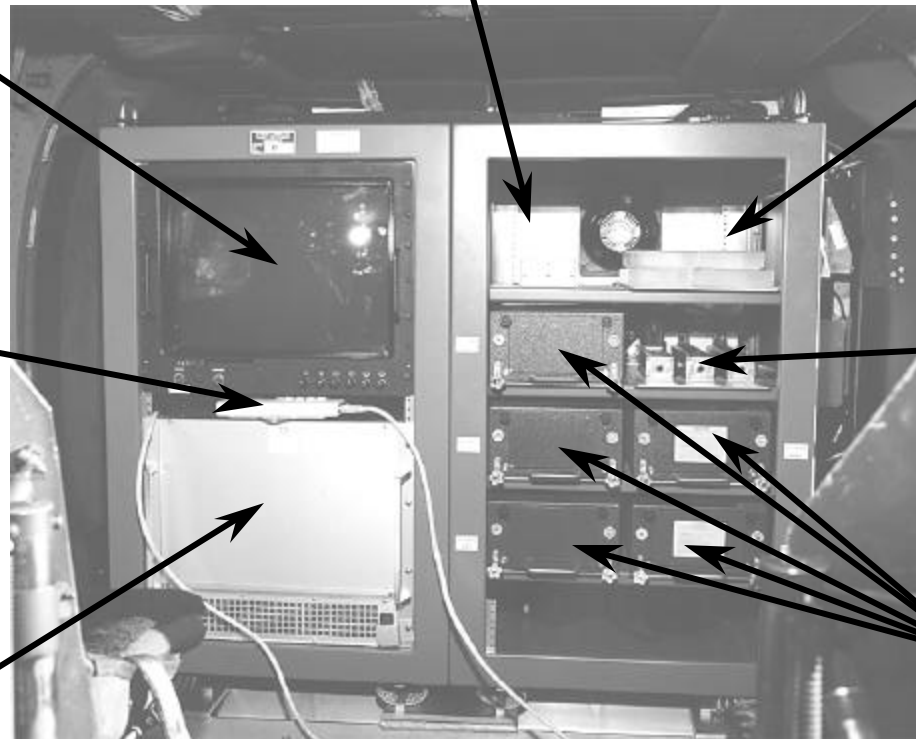
**Keyboard,
Aydin, KBTU**

**VME Chassis,
Elma, Type 12**

**1553 Data
Recorder,
TESCO, DDI v2**

Power Strips

**Tape Drives,
Metrum,
MARS-IIe**





SPECIALIZED UV/IR RADIOMETER SUITES



IR

Video

UV

■ Built for Signature Characterization

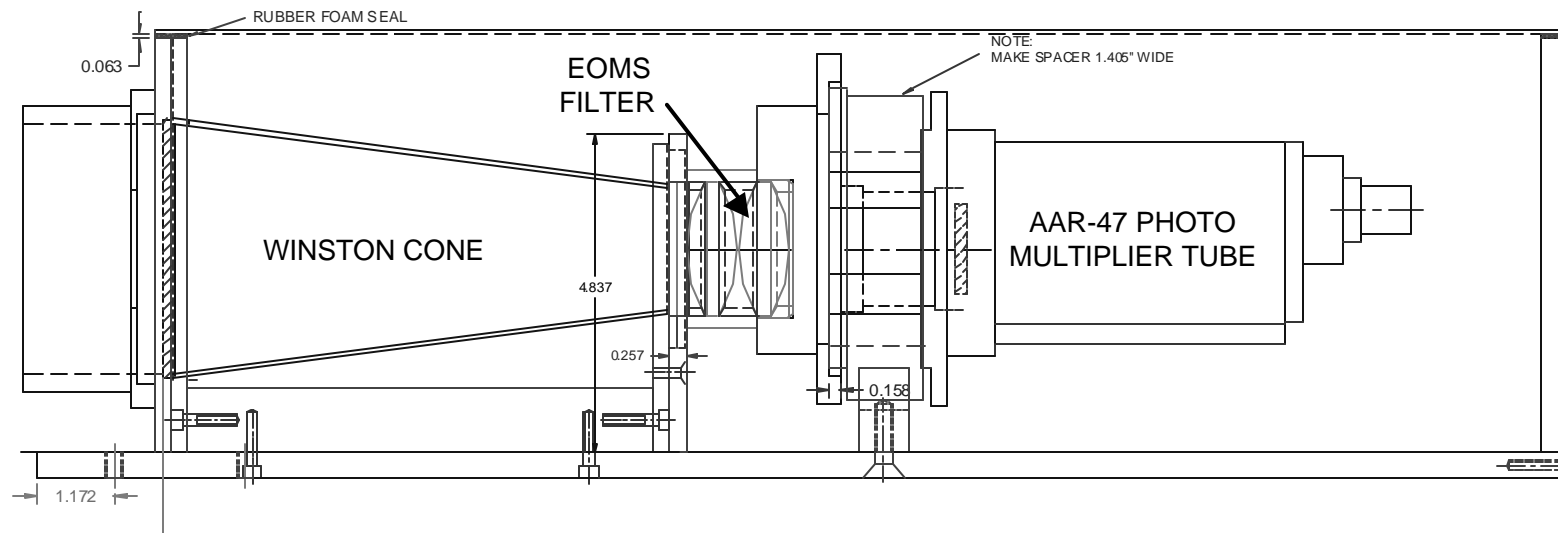
- × Missiles
- × Potential false alarm sources (PFAS)
- × Missile simulators (MEOS)

■ 4 UV/IR Radiometer Suites

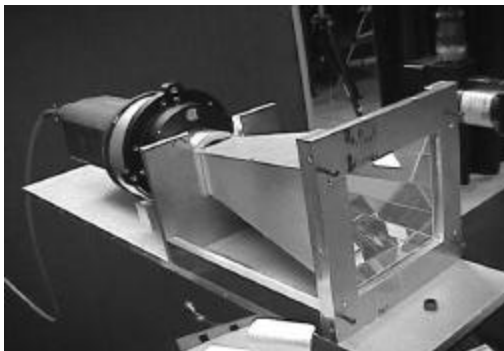
- × System bandpasses
- × Time-correlated UV and IR
- × Remote operation and data transfer
- × 1-2kHz sample rate
- × IR responsivity
 - ↓ High gain $\sim 3.55e-7$ (w/cm²/v)
 - ↓ Low gain $\sim 9.00e-5$ (w/cm²/v)
- × IR Filter Transmission
 - ↓ ND1-A1 = $10^{-0.99}$
 - ↓ ND2-A1 = $10^{-1.99}$
 - ↓ ND3-A1 = $10^{-2.91}$
- × Data collection for up to 15 min



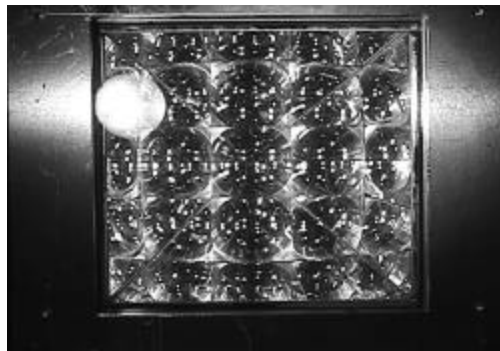
UV RADIOMETER



LRAD-II Optical/Mechanical Design Overview – Side view



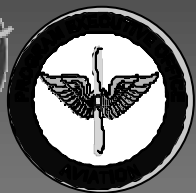
View of Optical Train



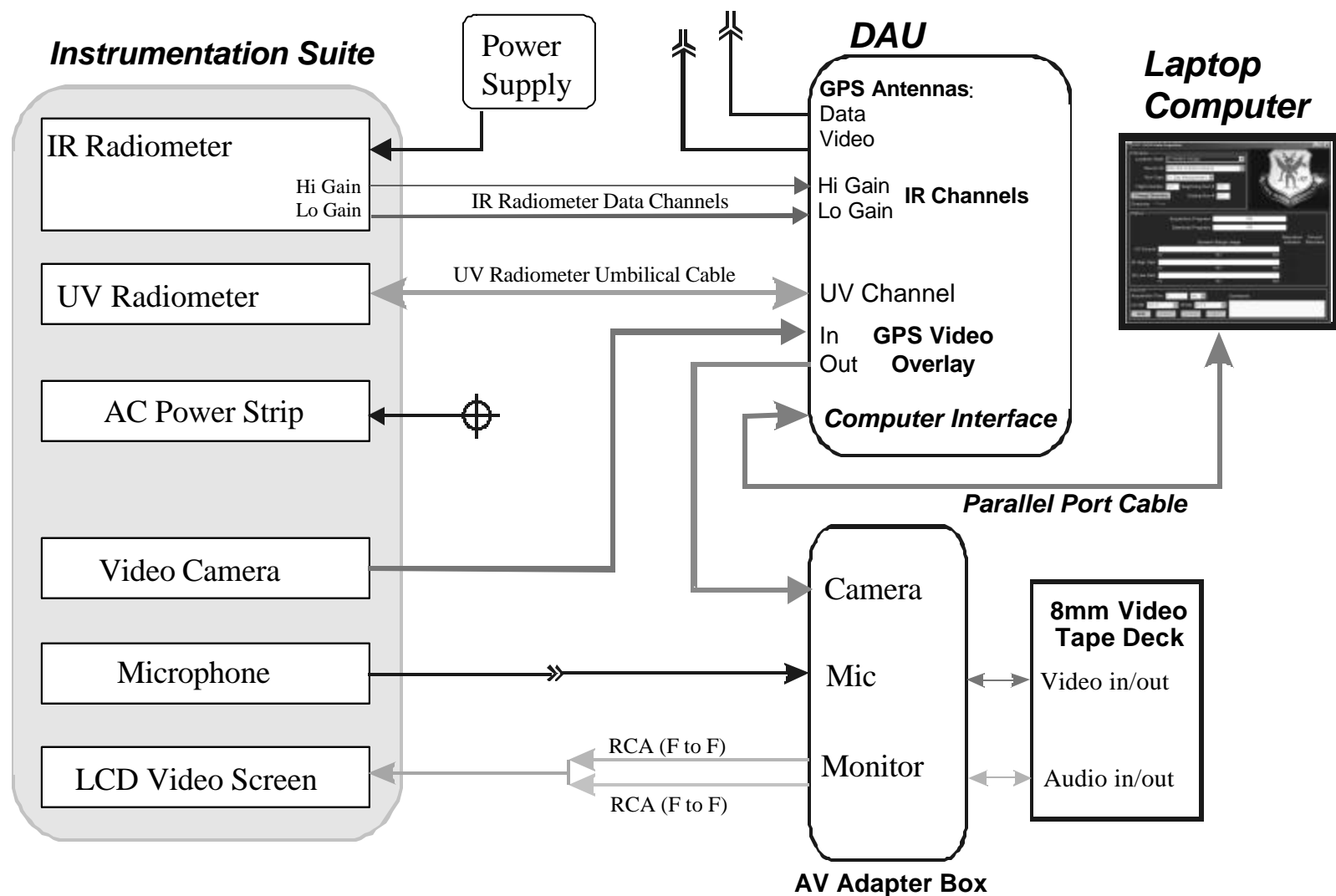
Appearance of Front-End Optical Assembly



UV/IR Suite



GENERAL OPERATIONAL SETUP DIAGRAM FOR UV/IR RADIOMETER SUITE





QUICK-LOOK OF DATA

■ Real Time/Near Real Time

- × Ozone concentration
- × MET parameters
- × Most recent aerosol size distribution
- × UV/IR signature recording verification
- × SMEOS BBM output voltage

‘ Short Turnaround

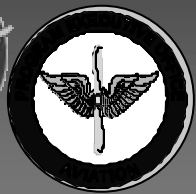
- × UV coefficients (20 min.)
- × Common source measurements (30 min.)
- × Corrected UV/IR irradiance over time (1 hr.)

‘ Daily/24-hour

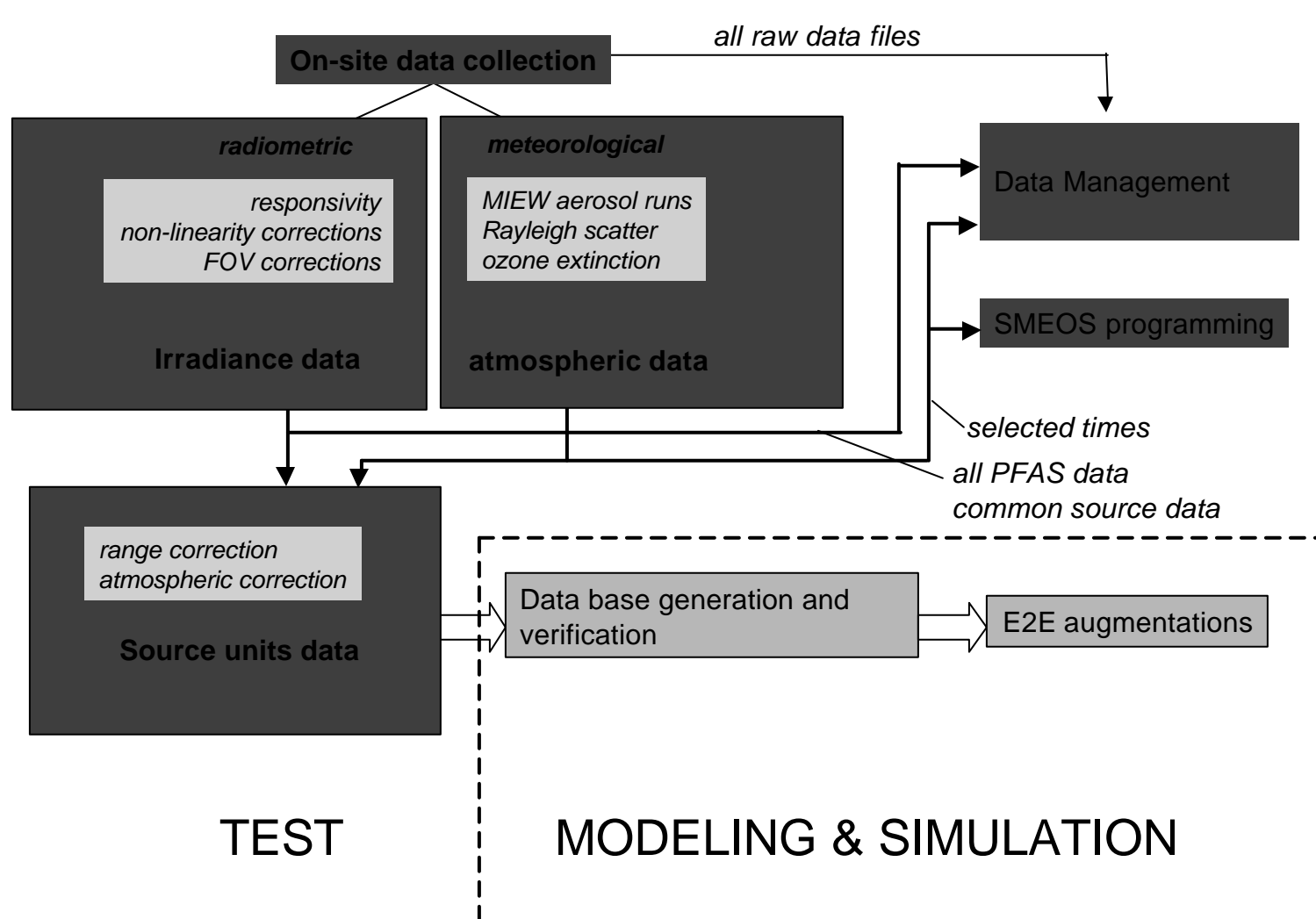
- × SMEOS UV/IR witness sensor comparisons
- × SMEOS received signal analysis

‘1 Week

- × UV/IR irradiance measurements converted on site from engineering units to source units

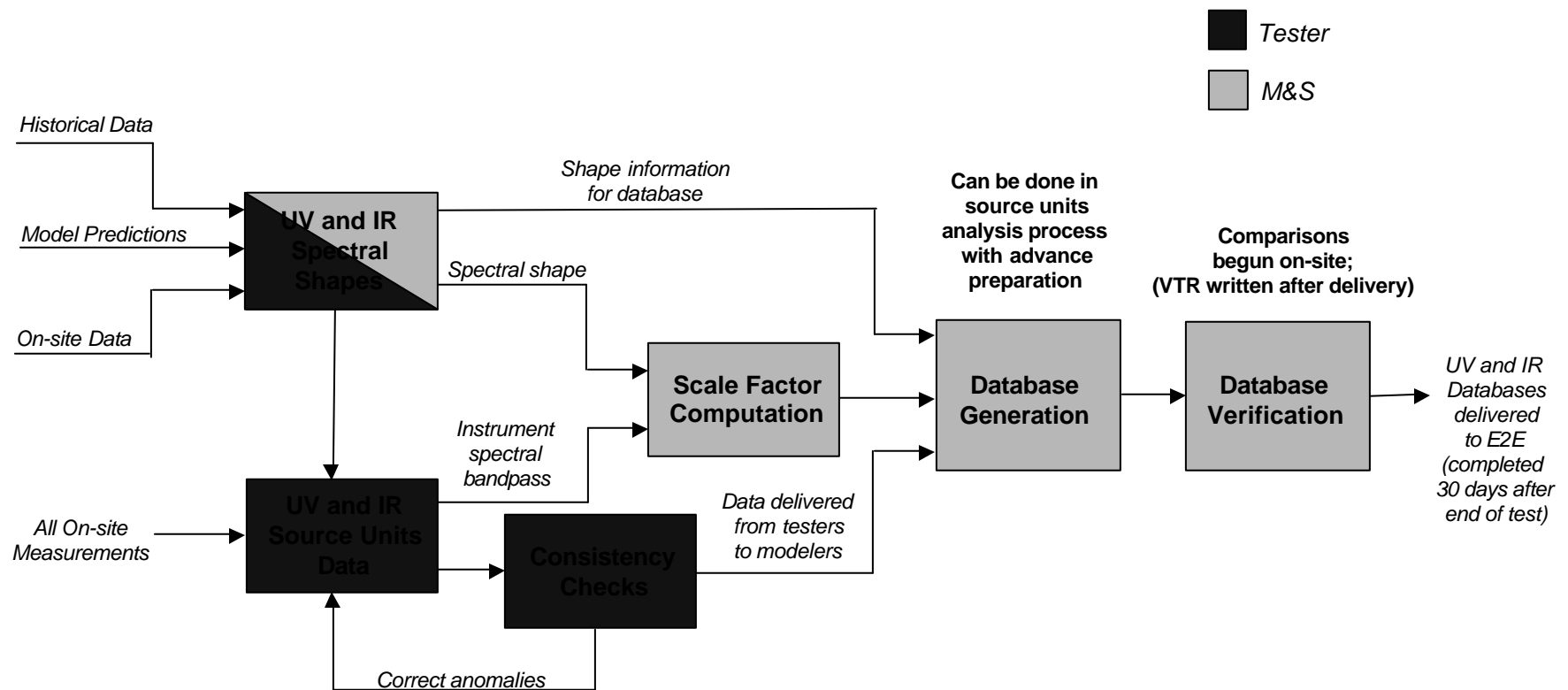


DATA ANALYSIS PROCESS AND FLOW





PFAS DATABASE GENERATION



- Process starts with validated source unit data
- Spectral shapes (or reasonable estimates) required along with source unit data



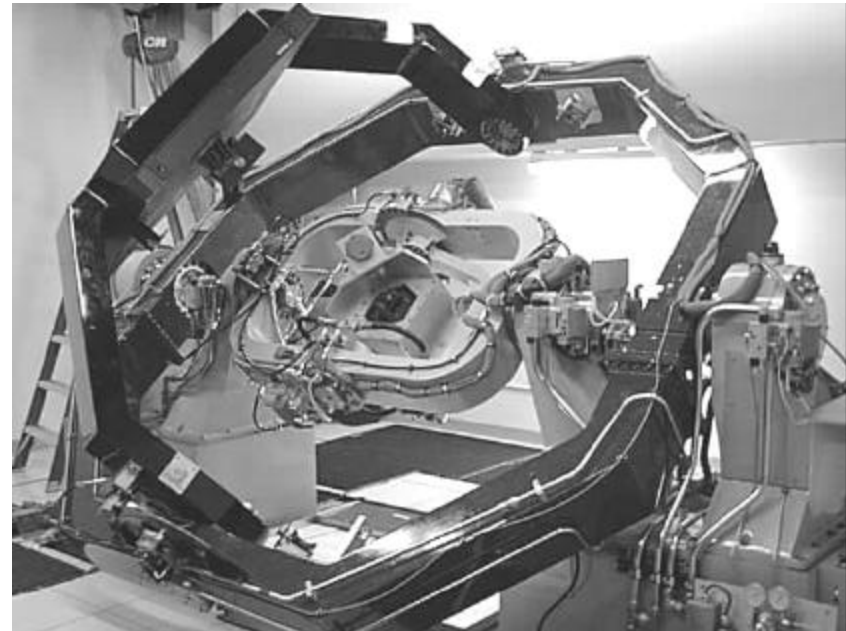
HARDWARE-IN-THE-LOOP (HITL)

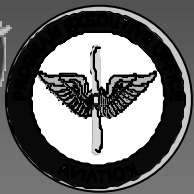
- Determine uninstalled system performance (e.g., Line Replaceable Units/Weapons Replaceable Assemblies) against simulated threats by building a statistical database of performance parameters.
- Verify compliance with the system specification in high performance platform environments that cannot be open-air tested due to platform maneuver rate limitations and safety considerations.



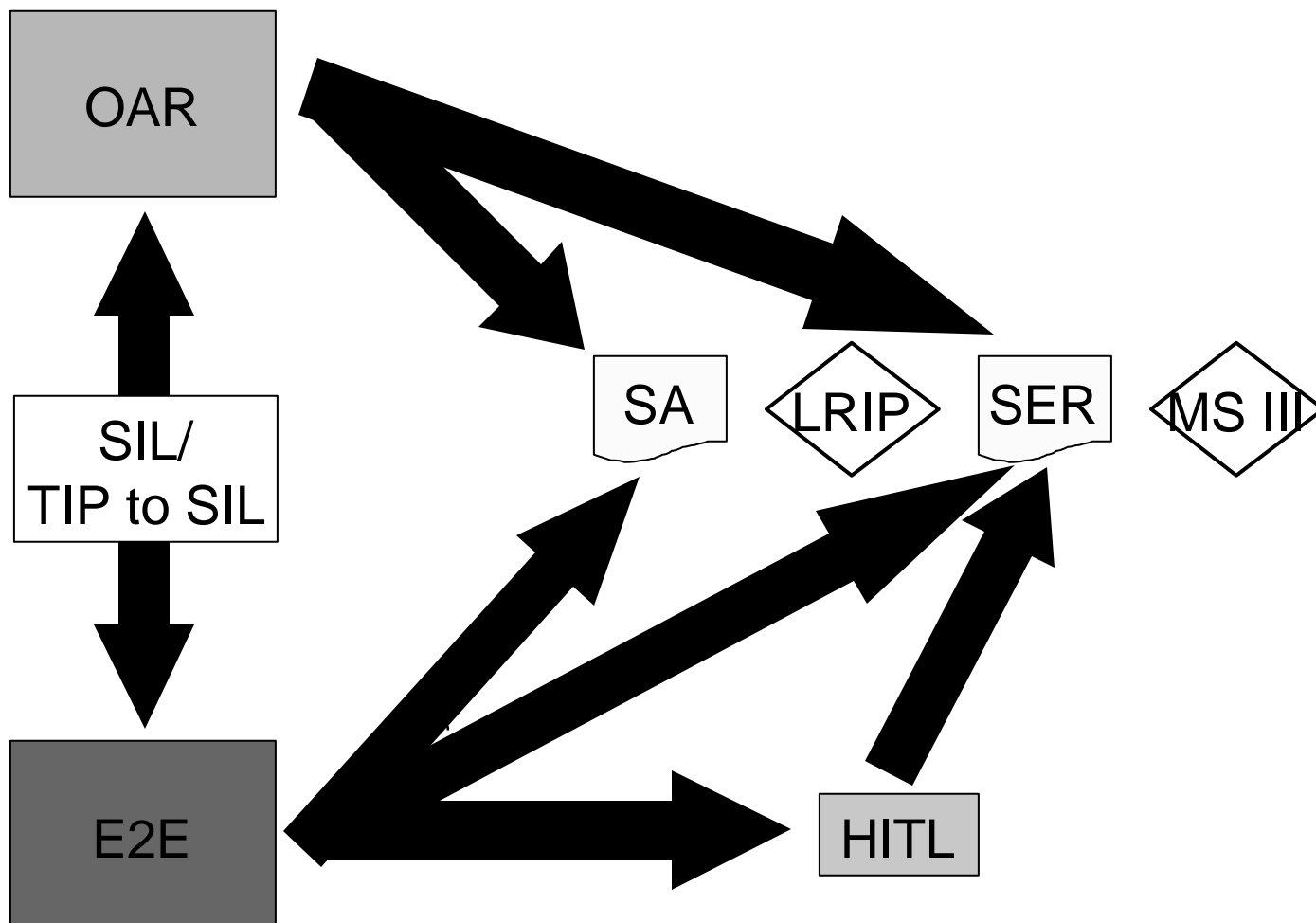
HARDWARE-IN-THE-LOOP (HITL)

- System contractor's Jam Lab has been established as a HITL asset
 - × 3 sensors and ECU on rate table
 - × Single moving projector
 - ↓ Direct view
 - ↓ Scene amplitudes, temporal profiles & motion
 - ↓ Scene shape not variable
 - × Multiple sources and scene shape effects testing transferred to SIL
 - × Scenes & rate table motion driven by E2E model
 - × Minimal integration risks





MILESTONE DECISION SUPPORT PROCESS





SUMMARY

- E2E Simulation has supplemented live tests with more than 3200 model runs.
- Several hundred SIL runs with recorded flight data will support a statistically significant FAR assessment.
- MEOS has successfully portrayed 5 missiles at simulated ranges from 2 to 5 kilometers, providing a reliable and cost effective missile simulator.
- HITL can provide the foundation for a national test asset.

**THE RESULT IS A MORE ROBUST TEST PROGRAM,
WITH SUBSTANTIALLY FEWER FIRINGS, AT A
LESSER COST, AND AT LOWER RISK FOR
FOLLOW-ON TESTS.**